Quo Vadis, Geo-scientific Mapping of States?

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Abstract. Geo-scientific mapping of States is understood as a complex system. Selected geo-scientific map series of the Free State of Saxony and of the Federal Republic of Germany are in the focus of the study. The analysis ascertains two categories of deficiencies: frequent and serious deficiencies. The results of the analysis are presented by tables and brief explanations. The primary purpose of the study is to promote a principal elaboration of the geo-scientific map series of States. In order to arrive at an improved level, dimension-specific space units, basis maps and complementary maps will be the keys.

Keywords: Geo-scientific map series, map deficiencies

1. Introduction

Comprehensive geo-scientific mapping of States results in map series of the States. Geo-scientific map series present geo-scientific parameters, geo-components, the natural landscape or the landscape in total, and reflect the geo-scientific knowledge of an epoch. They are mostly the output of costly and lengthy projects.

The need for geo-scientific map series of States globally increases. The topical challenges are great: global and regional climate change, increase of natural disaster risks, shortage and exhaustion of natural resources, permanent soil loss, global increase of population, growing mass tourism. Necessarily the question arises: How will the geo-scientific mapping of States develop?

2. Analysis of Selected Map Series of States

Saxony and Germany are birth places of major geo-scientific mapping efforts of states and countries: Geological Mapping since 1798 (A. G. Werner), Geomorphic Mapping since 1912 (S. Passarge), Forest Site Mapping since 1926 (G. Krauß), Soil Evaluation since 1934 (W. Rothkegel), Natural Landscape Division since 1943 (J. Schmithüsen), Mapping of the Potential Natural Vegetation since 1959 (R. Tüxen), Geo-ecological

Mapping since 1961 (E. Neef). Since 1990, new geo-scientific map series of the Free State of Saxony have been elaborated, among them the Soil Map 1:50 000, the Natural Landscape Map 1:50 000, and the Maps of the Potential Natural Vegetation 1:50 000 and 1:200 000.

It seems to suggest itself to analyse geo-scientific map series of the Free State of Saxony and of the Federal Republic of Germany. The selected map series were arranged according to geo-components. The table 1 shows the status of geo-scientific mapping in the Free State of Saxony and the Federal Republic of Germany based on selected map series.

Geo-scientific map series		Most important space units	Dimensions of the space units
Map series of the Free State of Saxony			
GK 25	Geological Map	Rocks	n. def.
HGK 50	Hydro-geological Map Series	Regional GWL and GWS	n. def.
KK 300	Climate Map	Climate steps	n. def.
GMK 750	Geo-relief Map	Geo-relief forms	n. def.
BK 50	Soil Map	Soil form societies	Nano-chorological
BSK 10	Soil Evaluation Map	Areas of soil classes	Latently topological
PNV-K 50	Map of the Potential Natural Vegetation	Mapping units	n. def.
FSK 10	Forest Site Map	Site forms	Topological
MMK 100	Medium-scale Agricultural Site Mapping	Regional site types	Nano-chorological
NRK 50	Natural Landscape Map	Micro-geochores	Micro-chorological
Map series of the Federal Republic of Germany			
GK 25	Geological Map	Rocks	n. def.
GMK 25	Geomorphic Map	Prozess areas	n. def.
BK 25	Soil Map	Soil form societies	Nano-chorological
BSK 5	Soil Evaluation Map	Areas of soil classes	Latently topological
PNV-K 200	Map of the Potential Natural Vegetation	Vegetation units	n. def.
FSK 5	Forest Site Map	Site forms	Topological
GÖK 25	Geo-ecological Map	Geo-ecological basic units	Topological
GLA-K 200	Map of the Geographical Land Survey	Natural landscape units	n. def.
NRG-K 1000	Map of the Natural Landscape Division	Natural landscape units	n. def.

Table 1. Geo-scientific map series of the Free State of Saxony and the Federal Republic of Germany.

The names of the map series are abbreviated. The (German) abbreviations are identically used in the sections below. The table 1 additionally contains the abbreviations GWL (aquifer) and GWS (impermeable layer).

The overview table can of course not claim completeness. The selected map series were analysed. Objects of analysis were in particular the most important space units and their dimension, significance for local information retrieval, comprehensibility, generalisation, actuality, production time, completion and unification of the map series.

Afterwards the map series were investigated with regard to deficiencies. The analysis resulted in two categories, namely frequent and serious deficiencies. The signs in the table 2 have the following meaning: 1 = existing, (1) = partially or latently existing, **0** = not existing.

Map series	Dimension-specific space units	Basis maps	Completeness	Update
Map series of the Free State of Saxony				
GK 25	**0**	1	**0**	(1)
HGK 50	**0**	**0**	1	**0**
GMK 750	**0**	**0**	1	**0**
KK 300	**0**	**0**	1	**0**
BK 50	1	**0**	1	**0**
PNV-K 50	**0**	1	1	**0**
BSK 10	(1)	1	1	(1)
FSK 10	1	1	1	(1)
MMK 100	1	**0**	1	**0**
NRK 50	1	**0**	1	**0**
Map series of the Federal Republic of Germany				
GK 25	**0**	1	**0**	(1)
GMK 25	**0**	**0**	**0**	**0**
BK 25	1	1	**0**	**0**
BSK 5	(1)	1	1	1
PNV-K 200	**0**	**0**	**0**	**0**
FSK 5	1	1	**0**	(1)
GÖK 25	1	**0**	**0**	**0**
GLA-K 200	(1)	**0**	**0**	**0**
NRG-K 1000	**0**	**0**	1	**0**

Table 2. Deficiencies in geo-scientific map series of the Free State of Saxony and the Federal Republic of Germany.

Some map series (GMK 25, GÖK 25, PNV-K 200) consist of exemplary sheets only; several others (BK 50, HGK 50, PNV-K 50, PNV-K 200, GLA-K 200, KK 300, GMK 750, NRG-K 1000) have only limited significance for local information retrieval. The GMK 25 bears academic content. Some map

series (GLA-K 200, NRG-K 1000) are historic in character and out-dated; most map series (FSK 10, GK 25, GÖK 25, GLA-K 200, and NRG-K 1000) have never been updated. The tables 1 and 2 prove that some deficiencies are frequent and some of them are serious. Serious deficiencies are

- incompleteness (exemplary maps),
- no dimension-specific space units,
- no basis maps,
- academic content (low practical significance),
- historical content (missing update),
- century work with regard to the production,
- no complementary maps,
- no national unification.

The geo-scientific map series of the Free State of Saxony and the Federal Republic of Germany altogether do not represent anymore the highest international reference level.

3. Elaboration of Map Series of States

Desirable elaboration principles for the geo-scientific map series of States are easily derivable from the existing serious deficiencies. New geo-scientific map series of States shall fulfil the following demands:

1. They shall have dimension-specific space units.
2. They shall have the character of basis maps.
3. They shall have complementary maps.
4. They shall be locally indicative and understandable.
5. They shall be published in short-term and as complete series.
6. They shall be unified as well nationally as internationally.

The demands will briefly be explained.

3.1. Dimension-specific Space Units

Only one half of the selected geo-scientific map series of the Free State of Saxony possesses dimension-specific space units (table 1). The dimensions vary between topological (FSK 10), latently topological (BSK 10), nano-chorological (BK 50, MMK 100) and micro-chorological (NRK 50). The dimension of the space units in the remaining map series is not determined.

The map series of the Federal Republic of Germany shows a similar picture (table 1). The dimensions change between topological (FSK 5, CÖK 25), latently topological (BSK 5) and nano-chorological (BK 25). Most map series indicate no dimension of the space units. Consequently, the map series are only partially comparable.

3.2. Basis Maps

The maps of largest scale within any map class are termed basis maps (Grundkarten) (Sandner 1981). The geo-scientific basis maps contain hard data. Their underlying space units represent the topological dimension. Secondary maps (associated with secondary scales, in German "Folgekarten") can comparatively easily be derived from geo-scientific basis maps. The ideal set of geo-scientific basis maps of the Free State of Saxony is presented in table 3.

Ideal geo-scientific basis maps		Dimension-specific space units	Dimensions	Already existing
QGK 10	Quarternary Geological Map 1:10 000	Periglacial strata	Latently topological	**0**
HGK 10	Hydro-geological Map 1:10 000	Local GWL and GWS	Topological	**0**
GMK 10	Geomorphographical Map 1:10 000	Relief facet societies	Topological	**0**
KK 10	Climate Map 1:10 000	Climate forms	Topological	**0**
BK 10	Soil Map 1:10 000	Soil forms	Topological	**0**
BSK 10	Soil Evaluation Map 1:10 000	Areas of soil classes	Latently topological	1
VK 10	Vegetation Map 1:10 000	Vegetation forms	Topological	**0**
FSK 10	Forest Site Map 1:10 000	Site forms	Topological	1
GÖK 10	Geo-ecological Map 1:10 000	Geo-ecological basic units	Topological	**0**

Table 3. Ideal geo-scientific basis maps of the Free State of Saxony.

Until present, no geo-scientific basis maps exist apart from the BSK 10 and the FSK 10. The GMK 10 (Geomorphographical Map) would eventually allow a relatively speedy production. In the table only vegetation (VK 10) has been considered, but not the fauna.

3.3. Complementary Maps

Complementary map series complement each other with regard to the content covered. The different geo-scientific space units are compliant; they are dimension-specific and all fall into the topological dimension. This is associated with identical or neighbouring map scales (table 4).

Complementary map series		Base maps
QGK 10	Quarternary Geological Map 1:10 000	---
HGK 10	Hydro-geological Map 1:10 000	QGK 10, BK 10, GMK 10
GMK 10	Geomorphographical Map 1:10 000	---

KK 10	Climate Map 1:10 000	GMK 10, FNK 10, HGK 10, BK 10
BK 10	Soil Map 1:10 000	GK 10, GMK 10
VK 10	Vegetation Map 1:10 000	BK 10, KK 10, GMK 10
PNV-K 10	Map of the Potential Natural Vegetation 1:10 000	FSK 10, BSK 10, KK 10
BSK 10	Soil Evaluation Map 1:10 000	---
FSK 10	Forest Site Map 1:10 000	BK 10, GMK 10, KK 10
GÖK 10	Geo-ecological Map 1:10 000	BK 10, GMK 10, KK 10, VK 10

Table 4. Potential complementary geo-scientific map series of the Free State of Saxony.

A networking of several geo-scientific information systems and databases makes it possible to arrive at complementary geo-scientific map series. Simple equations shall demonstrate this fact:

HGK 10 = f (GK 10 + BK 10 + GMK 10)
KK 10 = f (GMK 10 + FNK 10 + HGK 10 + BK 10)
BK 10 = f (GK 10 + GMK 10)
VK 10 = f (BK 10 + KK 10 + GMK 10)
PNV-K 10 = f (FSK 10 + BSK 10 + KK 10)
FSK 10 = f (BK 10 + GMK 10 + KK 10)
GÖK 10 = f (QGK 10 + GMK 10 + BK 10 + KK 10)

The intended geo-scientific map series has been placed at the beginning of each of the previous lines. The necessary geo-scientific basis maps are bracketed. The map series QGK 10, GMK 10 and BSK 10, however, cannot be based upon a subset of geo-scientific basis maps.

Complementary map series are founded on the construction kit principle. An envisaged future climate map KK 10, for instance, needs dimension-specific units of the climate parameters relief, land use, water and soil. They are available within the base maps GMK 10, FNK 10, HGK 10 and BK 10 as starting material (table 4).

3.4. Local Significance and Comprehensibility

Basis maps with geo-scientific space units of the topological dimension ensure local significance, meaning the capability to derive logical decision support at any geographic spot covered.

Any user shall understand geo-scientific maps. The GMK 25 is a rather deterring example of an academic map. Summary maps and century works are to be avoided. The principle of a construction kit has proved to be efficient. Basic principles are explained in a well understandable way; map legends are formed, if possible, in a tabular or matrix form; comprehensive or general legends are avoided. Classic examples for a map interpretation can be enclosed.

3.5. Production Time

The production times of geo-scientific map series of States is very variable. It ranges from less than 10 years (NRK 50) to more than 140 years (GK 25). The GK 25 is an example of extremes: The project started in 1872 and has been completed in 1895 within the Kingdom of Saxony. In comparison, the GK 25 of the Federal Republic of Germany can be termed a century work which even nowadays still shows major gaps.

But these data are hardly comparable. For that purpose, they must be related to geo-scientific basis maps. A short-term production (up to 10 years including the set-up of a concept) is not only desirable but also possible. Map series like the HGK 50 and the MMK 100 of the German Democratic Republic as well as the NRK 50 and the PNV-K 50 of the Free State of Saxony verify this statement.

3.6. National and International Unification

The national unification (standardisation) shall really be undertaken with a cooperation of cartographers. A disproportionate federalism hinders the progress. Since the Second International Geological Congress (1881) the geological maps are the classic example of an international unification of geo-scientific maps.

4. Conclusions

The question reads actually not: “Quo vadis, geo-scientific mapping of States?” It should rather say: “How shall the geo-scientific mapping of States further proceed?” Elaboration and full coverage of the geo-scientific map series of States shall be the primary target. The orientation towards dimension-specific space units, basis maps and complementary maps is the driving force for a fundamental perfection. Thus, the map contents can be optimised and the production costs of the map series even be reduced.

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References

Arbeitsgruppe Boden der Geologischen Landesämter und der Bundesanstalt für Geowissenschaften und Rohstoffe der Bundesrepublik Deutschland (2005) Bodenkundliche Kartieranleitung. 5. Auflage. Hannover

Bohn U mit Beiträgen von Korneck D, Meisel K (1995) Vegetationskarte der Bundesrepublik Deutschland 1:200.000 - Potentielle natürliche Vegetation - Blatt CC 5518 Fulda. Schriftenreihe für Vegetationskunde 15

Czajka W, Klink H-J (1967) Die naturräumlichen Einheiten auf Blatt 174 Straubing. Geographische Landesaufnahme 1:200.000 – Naturräumliche Gliederung Deutschlands. Bundesanstalt für Landeskunde und Raumforschung, Bad Godesberg

Haase G, Barsch H, Hubrich H, Mannsfeld K, Schmidt R et al. (1991) Naturraumerkundung und Landnutzung. Geochorologische Verfahren zur Analyse, Kartierung und Bewertung von Naturräumen. Akademie-Verlag, Berlin (Beiträge zur Geographie 34)

Hydrogeologisches Kartenwerk der DDR 1:50.000:
Nutzerrichtlinie für die Hydrogeologische Grundkarte - Karte 1, Karte der hydrogeologischen Kennwerte - Karte 2.1, Karte der Hydroisohypsen - Karte 2.2. Halle 1987
Nutzerrichtlinie für die Karte der Grundwassergefährdung - Karte 4. Halle 1987
Nutzerrichtlinie für die Hydrogeologische Grundkarte - Tertiäre Grundwasserleiter - Karte 5. Halle 1988

Kopp D, Schwanecke W (1994) Standörtlich-naturräumliche Grundlagen ökologiegerechter Forstwirtschaft. Grundzüge von Verfahren und Ergebnissen der forstlichen Standortserkundung in den fünf ostdeutschen Bundesländern. Deutscher Landwirtschaftsverlag, Berlin

Krauß G, Schanz H (1930) Beitrag zur forstlichen Bodenkartierung (Standortskartierung). Silva 18: 153-159

Kugler H et al. (1981) Atlas DDR, Blatt 2: Georelief und aktuelle reliefbildende Vorgänge. VEB Hermann Haack, Gotha, Leipzig

Legenden und Erläuterungsbände zu den Standortskarten der staatlichen Forstwirtschaftsbetriebe der DDR. Potsdam 1954-1990

Leser H (1976) Das GMK-Projekt. Kartographische Nachrichten 26: 169-177

Leser H, Klink H-J (1988) Handbuch und Kartieranleitung Geoökologische Karte 1:25.000 (KA GÖK 25). Forschungen zur deutschen Landeskunde 228

Meynen E, Schmithüsen J, Gellert J F, Neef E, Müller-Miny H, Schultze J H (1962) Handbuch der naturräumlichen Gliederung Deutschlands. Bundesanstalt für Landeskunde und Raumforschung, Bad Godesberg

Rothkegel W, Herzog H (1935) Das Bodenschätzungsgesetz. Heymann, Berlin

Sandner E (1981) Bemerkungen zu den kartographischen Termini „Grundkarte“ und „Grundlagenkarte“. Vermessungstechnik 29: 196-199

Sandner E (1987) Vorschläge zur Bewertung landschaftskundlicher Karten. Vermessungstechnik 35: 308-312

Sandner E (1999) Die Naturraumkarte 1:50.000 des Freistaates Sachsen. Kartographische Nachrichten 49: 105-110.

Sandner E in cooperation with Kurze J (2006) Map Falsifications in Medium-scale Agricultural Site Mapping. Archiv zur DDR-Staatssicherheit 7: 133-146

Schmidt P A, Hempel W, Denner M, Döring N, Gnüchtel A, Walter B, Wendel D

(2002) Potentielle Natürliche Vegetation Sachsens mit Karte 1:200.000. Sächsisches Landesamt für Umwelt und Geologie

Schmidt R, Diemann R (1981) Erläuterungen zur Mittelmaßstäbigen Landwirtschaftlichen Standortkartierung (MMK). Forschungszentrum für Bodenfruchtbarkeit Müncheberg der Akademie der Landwirtschaftswissenschaften der DDR, Bereich Bodenkunde / Fernerkundung, Eberswalde

Schwanecke W, Kopp D (1996) Forstliche Wuchsgebiete und Wuchsbezirke im Freistaat Sachsen. Schriftenreihe der Sächsischen Landesanstalt für Forsten 8

Zitzmann A (1994) Geowissenschaftliche Karten in der Bundesrepublik Deutschland. Zeitschrift der Deutschen Geologischen Gesellschaft 145: 38-87